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FOR

REVERSE PROXY MECHANISM

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REVERSE PROXY MECHANISM

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FIELD OF THE INVENTION

The present invention relates generally to the processing of electronic content requests, and more specifically, to a reverse proxy mechanism for retrieving electronic content that is associated with a local network.

BACKGROUND OF THE INVENTION

Society has become extremely dependent upon computers and the electronic content that they contain. As used herein, the term electronic content is broadly defined to include any form or type information that may be electronically read by a computer. For example, the term electronic content includes, but is not limited to, emails, calendar information, word processing documents, pictures, news articles, television programming information, or any other type of information that may be electronically read by a computer. The electronic content may exist in a variety of different content formats, that includes but is not limited to HTML, XML, WML, Microsoft Word®, WordPerfect®, JPEG, GIF, or any other format that can be electronically read by a computer.

Recently, a movement has been made to allow users to remotely access this electronic content information through the use of "highly constrained" devices (e.g., cellular phones, Palm Pilots, PDAs, etc.). For example, Sinia Corporation has developed a product that provides users with the flexibility to remotely connect to a local network (for example, a company's private network) via a Highly Constrained device and to retrieve the user's email and calendar information from potentially anywhere in the world.

Currently, in addition to retrieving electronic content information, there is need to allow users to access the information that is associated with a link within electronic content. For example, in the Web environment, electronic content often includes links (often generally referred to a hypertext links) that are associated with other electronic content. By selecting a particular link within an electronic content, the user's browser automatically communicates with an Internet Domain Name Service (DNS server) to resolve the address of the electronic content and to request the content from a server that is associated with the resolved address.

However, if a link is associated with an electronic content whose address cannot be resolved by an Internet DNS server, for example electronic content that is stored on a local network, the user's browser will not be provided with the correct address of the electronic content and thus will have no way of retrieving the content.

For example, many companies maintain their own local networks, often referred to as local intranets. These local networks provide a means for managing and controlling access to the company's electronic content information from the outside world. For in many local networks, a local DNS server is used to dynamically allocate IP addresses for accessing the local servers that manage a company's electronic content information. Because the IP addresses are only known within the local network, a DNS server outside

the local network cannot resolve the address of a link that is associated with an electronic content that is stored within one of the local network servers. Thus, if after remotely retrieving electronic content the user selects a link within the content that is associated with electronic content stored on a local network, the Internet DNS server will not be able to correctly resolve the address of that content, thus causing the user's browser to indicate that the electronic content could not be found or alternatively to provide other, incorrect content based on a "best" guess by the Internet DNS server.

Moreover, local network servers are often assigned local host names that are not known outside the local network. If a user using a highly constrained device selects a link that is associated with a local host name that is not known outside the local network, the Internet DNS server will again not be able to resolve the address of the link and therefore will not be able to retrieve the correct content.

Based on the foregoing, there is a clear need for a mechanism that allows users to remotely access electronic content and to select links within the content to retrieve locally stored content that is associated with a company's local network.

SUMMARY OF THE INVENTION

A method and apparatus are provided for processing requests for delivery of electronic content. According to one aspect of the invention, a request for delivery of first electronic content is received, where (1) the request is for delivery of the first electronic content to a destination client that is not on a local network, and (2) the first electronic content includes one or more links that are only resolvable within the local network. In response to the request, the first electronic content is retrieved, and first updated content is generated by modifying the one or more links associated with the first electronic content to include information identifying a server that can be addressed outside the local network. The first updated content is then delivered to the destination client.

According to one aspect of the invention, when a user of the destination client selects one of the modified links, the server information in the modified link causes a message to be sent to the server. If the server is within the local network, then the server may respond to the message by retrieving and delivering second electronic content that was associated with the link before the link was modified. If the server is outside the local network, then the server may send a message to another server within the local network to retrieve and deliver the second electronic content that was associated with the link before the link was modified. Links within the second electronic content may be modified in the same manner as were the links in the first electronic content.

The invention also encompasses a computer-readable medium, a computer data signal embodied in a carrier wave, and an apparatus configured to carry out the foregoing steps. Other features and aspects will become apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

FIG. 1 illustrates a block diagram of a reverse proxy mechanism in which the present invention may be utilized;

FIG. 2A illustrates an electronic document that includes links that are not resolvable outside the local network;

FIG. 2B illustrates a modified electronic document in which the links have been updated to be resolvable outside the local network;

FIG. 2C illustrates a decorated modified electronic document in which an additional link has been inserted into a modified electronic document;

FIG. 2D illustrates an example of a link that may be sent to the reverse proxy server to initiate the process of providing access to locally stored electronic content;

FIG. 3 is a flow diagram that illustrates an example of a method for processing electronic content requests that are received from clients outside the local network; and

FIG. 4 is a block diagram of a computer system with which an embodiment may be carried out.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A reverse proxy mechanism is provided for retrieving electronic content that is associated with a local network. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the present invention.

OPERATIONAL CONTEXT

A reverse proxy mechanism is provided for retrieving, from outside a local network, electronic content that is associated with a local network. In one embodiment, a reverse proxy server is connected to a company's local network and configured to receive and resolve requests from clients outside the local network for locally stored electronic content. In response to receiving a request for electronic content that is associated with the local network, the reverse proxy server retrieves the content and generates a set of updated content by modifying the links associated with the electronic content to include information that identifies the reverse proxy server. The updated content is then delivered to the requesting client. By modifying the links to include information that identifies the reverse proxy server, when the user subsequently selects a link within the modified content, the reverse proxy server is guaranteed to receive the request. Thereafter, the reverse proxy server resolves the address of the content associated with the link, retrieves the content at that address, and again generates updated content by again modifying the links associated with that electronic content to include information

that identifies the reverse proxy server. This process may be performed repeatedly to provide remote access to the locally stored electronic content.

FIG. 1 is a block diagram of a reverse proxy system 100 upon which certain embodiments of the invention may be implemented. Generally, system 100 includes a client 102, a Wireless Access Protocol (WAP) Gateway 104, a reverse proxy server 106, one or more local servers 108-114, a non-local network 120, a local network 116 and a firewall 118.

Local network 116 is a network system comprising any number of network devices (e.g., servers, personal computers, workstations, printers, etc.). Local Network 116 may form part of a private LAN or WAN that is configured for communicating with the outside world through reverse proxy server 106. In one embodiment, network 228 is configured as a packet-switched network that can support such protocols as the HyperText Transport Protocol (HTTP). In certain embodiments, a firewall 118 may be configured to provide protection against unauthorized clients from connecting to network 116 and other devices that are logically behind the firewall.

Local Servers 108-114 represent computers, or groups of hardware or software components that execute as one or more computer systems. Local servers 108-114 are configured to manage and store electronic content, some of which may include links to other electronic content within local network 116. For example, local servers 108-114 may be configured as internal Web servers. In certain embodiments, a local DNS server is configured to dynamically assign IP addresses to local servers 108-114. For example, one of the local servers 108-114 may act as local DNS to dynamically assign local IP addresses to the different devices that are connected to local network 116.

Reverse proxy server 106 is a computer, or a group of hardware or software components or processes that cooperate or execute in one or more computer systems. The reverse proxy server 106 is coupled to the local network 116 and is configured as a portal device that controls remote access to the local network 116 and local servers 108-114. Reverse proxy server 106 may be logically located within firewall 118 or may be configured outside firewall 118 and thus potentially require authentication to access the resources of local network 116. In one embodiment, reverse proxy server 106 includes a servlet that is configured to respond to requests from clients that are located outside of local network 116. In certain embodiments, reverse proxy server 106 is configured to authentication and authorization, verifies identities, grants or denies authorizations, and logs accounting records.

As will be described in further detail below, reverse proxy server 106 is configured to retrieve electronic content from local servers 108-114 and to update ("wrap") the links within the content to include the address of reverse proxy server 106.

In certain embodiments, a WAP gateway device 104 is used to perform protocol conversions between protocols used within local network 116 and those used by clients outside local network 116. For example, WAP gateway 104 may be configured to translate messages from WAP to HTTP and from HTTP to WAP.

In one embodiment, client 102 is a cellular phone, Palm Pilot, or other highly constrained device, that is capable of communicating with reverse proxy server 106 via WAP gateway 104. Client 102 is used by or associated with a user 122. Although one client 102 is shown in FIG. 1 by way of example, any number of clients can be included in the system 100, and multiple connects may be simultaneously established between different client devices and reverse proxy server 106. In certain embodiments, client 102

is configured to execute a browser type application, such as Netscape Navigator®, Microsoft Internet Explorer® or other similar type of WAP or HTML browser application that has been developed for use in high constrained devices. User 122 can use the browser application to communicate with reverse proxy server 106, potentially through WAP gateway 104. In certain embodiments, user 122 may be required to enter a login ID and password which is used by reverse proxy 106 to authenticate the user 122 as being authorized to access the content of local network 116.

As depicted, client 102 is connected to a non-local network (i.e., a network other than local network 116) that does not have the ability to resolve address information that is associated with electronic content that is maintained with local network 116. For example, non-local network 120 may represent a private or public network, such as the Internet, which does not have the means for resolving links that are associated with electronic content that is maintained with local network 116. In addition, non-local network 120 may be formed using a variety of different mediums, including but not limited to electrical wire or cable, optical, or wireless connections.

PROCESSING ELECTRONIC CONTENT REQUESTS

FIG. 3 is a flow diagram that illustrates an example of a method for processing electronic content requests that are received from clients outside the local network. For explanation purposes, FIG. 3 is described in reference to the components of FIG. 1, FIG. 2A and FIG. 2B.

At block 302, reverse proxy server 106 receives a request from a client 102 for delivery of electronic content. For example, the received request may be for the delivery of electronic document 200 shown in FIG. 2A.

At block 304, reverse proxy 106 determines the location of the electronic content within local network 116. For example, using a local DNS, reverse proxy server 106 may determine that the requested electronic document 200 is located on local server 108.

At block 306, reverse proxy server 106 retrieves the electronic content from within the local network 116.

At block 308, reverse proxy server 106 identifies any links that are contained with the electronic content. For example, in retrieving electronic document 200, reverse proxy server 106 identifies that the electronic document 200 includes links 202, 204 and 206. In this example, link 202 includes an address portion 208 that corresponds to an address that is resolvable outside local network 116 (i.e., resolvable by the Internet DNS). Link 204 contains an address portion 210 that includes a numerical IP address ("10.3.4.5") that was assigned by the local DNS and thus is not resolvable outside local network 116. Link 206 contains an address portion 212 that includes an unqualified symbolic name ("www/stocks") that is an internal name within local network 116 and thus also not resolvable outside local network 116.

At block 310, reverse proxy server 106 determines whether the retrieved electronic content contains any links that need to be wrapped. For example, reverse proxy server 106 determines that links 202 and 204 are not resolvable outside local network 116 and thus addresses 210 and 212 need to be wrapped with information identifying reverse proxy server 106. In certain embodiments, although a link is resolvable outside local network 116, for example link 202, reverse proxy automatically wraps the link's address (i.e., address 208) to require any request based on selection of the link to travel via reverse proxy server 106. If the reverse proxy server 106 determines

that no links need to be wrapped, at block 318, the electronic content is delivered back to the requesting client unmodified.

Alternatively, if the reverse proxy server 106 determines that one or more links need to be wrapped, at block 312, reverse proxy server 106 generates a modified electronic content based on the contents of the electronic content that was retrieved.

At block 314, the reverse proxy server 106 updates any links that need to be wrapped and stores them within the modified electronic content. For example, as illustrated in FIG. 2B, reverse proxy server 106 updates address fields 210 and 212 to include a reference to reverse proxy server 106.

At block 316, reverse proxy server 106 delivers the modified electronic content back to the requesting client. Thereafter, when user 122 selects a wrapped link within the modified electronic content, the request for the electronic content is automatically forwarded first to reverse proxy server 106.

As shown by broken return arrow 318, the process of the electronic content requests can be recursively or repeatedly performed.

INITIATING ELECTRIC CONTENT REQUESTS

According to one embodiment, to access electronic content within the local network, the clients initially connect to the reverse proxy server. In one embodiment, a set of one or more links are stored as "favorites" within the browser application executing on the client. By selecting one of these links, a request is automatically sent to the reverse proxy server to initiate the process of providing access to locally stored electronic content via links that are only resolvable within the local network. For example, a user may store a URL that is linked to a Web page or "Deck" (a set of related pages

transmitted as a group in response to a single request) that is contained on reverse proxy server 106 and which provides an index into electronic content (for example, emails, financial reports, corporate directories, etc.) that are located within local network 116. The user may then select one of these links to begin accessing content that is stored within the local network 116. FIG. 2D illustrates an example of a link 290 that may be sent to the reverse proxy server to initiate the process of providing access to locally stored electronic content via links that are only resolvable within the local network. In this example, address portion 292 includes an external address portion 294 that identifies the reverse proxy server and which is resolvable outside the local network. In addition, address portion 292 also includes an internal address portion 296 that is associated with electronic content that resides within local network 116 and which is resolvable by the reverse proxy server but not resolvable outside local network 116.

In one embodiment, when a client initially connects to the reverse proxy server the reverse proxy server verifies that the address (URL) associated with the link is fully qualified. As used herein, the term "fully qualified" means that the URL contains a "scheme," typically "http:" or "https:," a host delimiter ("//"), and a hostname, plus the full path (list of directories) to the named resource. In one embodiment, to verify that the URL of the link is fully qualified the reverse proxy server examines the internal address portion of the URL to verify that it is resolvable by the reverse proxy server.

The following presents one example of the steps that a user may be perform to initially connect to the reverse proxy server. First, the user creates a "bookmark" containing the fully qualified URL of a document or service of interest. In this example, the document resides on a server (internal1) that is on their local intranet, and is invisible to external clients and Internet DNS servers outside their local intranet. For explanation

purposes, the bookmark URL created by the user is as follows:

http://internal1.company.com/directory.wml.

For further explanation purposes, the bookmark URL http://internal1.company.com/directory.wml. is assumed to be associated with a document on the local intranet that contains relative (non-fully qualified) links to weather.wml, stocks.wml, and time.wml:

```
<wml><card>
  <a href="weather.wml">Weather</a><br/>
  <a href="stocks.wml">Stocks</a><br/>
  <a href="time.wml">Time</a><br/>
</card></wml>
```

It is further assumed that the reverse proxy server is accessible from the Internet, and that it resides at https://www.company.com/RevProxy. ("reverse proxy server URL"). To cause the user's client to initially connect to the reverse proxy server, the bookmark URL must be wrapped with the reverse proxy server URL. A variety of methods may be used to wrap bookmark URLs with the reverse proxy server URL. For example, in one embodiment, software executing on the user's client is configured to automatically wrap the reverse proxy server URL around the bookmark URL in the user's bookmark list. For example, a plug-in or other software module may be configured on the client machine to allow the user to select specific bookmarks that are to be wrapped with information identifying the reverse proxy server. By selecting a desired set of links the user can create a list of "wrapped" links that are automatically sent to the reverse proxy server when selected.

For example, by selecting the bookmark URL above the user may cause the bookmark URL to be wrapped to generate the "wrapped" URL:

https://www.company.com/RevProxy/http://internal1.company.com/directory.wml.

Thereafter, when the user accesses (selects) the wrapped URL, the Reverse Proxy loads the document from the local intranet that is located at the fully qualified URL http://internal1.company.com/directory.wml and rewrites all of the links that are contained within the document. For example, the non-fully qualified link weather.wml is merge with the current fully qualified URL (http://internal1.company.com/directory.wml) to generate fully qualified link http://internal1.company.com/weather.wml.

Next, the fully qualified link is wrapped with the reverse proxy server URL by concatenating the URL of the Reverse Proxy (https://www.company.com/RevProxy), and a forward slash ("/"), to the fully qualified link to create the modified URL:

https://www.company.com/RevProxy/http://internal1.company.com/weather.wml

This process may then be performed on each of other relative non-fully qualified links (weather.wml, stocks.wml, and time.wml) to generate the following fully resolvable document:

```
<wml><card>
  <a
href="https://www.company.com/RevProxy/http://internal1.company.com/weat
her.wml">Weather</a><br/>
  <a
href="https://www.company.com/RevProxy/http://internal1.company.com/stoc
ks.wml">Stocks</a><br/>
  <a
href="https://www.company.com/RevProxy/http://internal1.company.com/time
.wml">Time</a><br/>
</card></wml>
```

Thereafter, when the user clicks on (selects) any of these links, the wrapping process is repeated for the next set of links that are contained within the retrieved document.

As previously indicated, several methods may be used to rewrite the URLs that are associated with a particular link. For example, the following Java code provides one example of how the reverse proxy server can ensure that the reverse proxy server is presented with fully qualified internal URLs in response to a user activating (e.g., selecting) a link in a page that was previously returned by the reverse proxy server. In this example, it is assumed that the variable *refURL* is an object of class java.net.URL that contains the URL of the document currently being accessed. (http://internal1.company.com/directory.wml). It is also assumed that the String variable *path* contains the URL currently being examined ("weather.wml") and that the String variable revProxyURL contains the address of the Reverse Proxy itself ("https://www.company.com/RevProxy").

Then, for each URL encountered, the following steps are performed to create and return the fully qualified and rewritten URL:

```
URL temp = new URL(refURL, path);
StringBuffer sb = new StringBuffer(revProxyURL);
sb.append("/");
sb.append(temp.toString());
return sb.toString();
```

DECORATED MODIFIED ELECTRONIC DOCUMENTS

In certain embodiments, in generating the updated content the reverse proxy mechanism further modifies ("Decorates") the updated content by including one or more additional links that did not exist in the content at the time it was retrieved. In one embodiment, the one or more additional links provide a user with the ability to jump to a

particular page that was not previously accessible via the originally retrieved content. FIG. 2C illustrates a decorated modified electronic document 270 in which an additional link 272 has been inserted into the modified electronic document 250 that was previously shown in FIG. 2B. By including one or more additional links within the modified content a mechanism is provided whereby a user may jump to a particular page that contains content for which the user desires access. In certain embodiments, the additional links are to content that is maintained by the reverse proxy server and/or the local network. For example, additional link 272 may be a link to the home page of the particular company that owns the local network. This home page may include information and/or links that provide access to the company's resources, such as employee mailboxes, the company's directory, news articles about the company, etc.

In other embodiments, the additional links are to content that is maintained outside the local network. For example, additional link 272 may be a link to content that is located on a server that provides global weather reports and which is outside the local network. In one embodiment, the additional links associated with content that is located outside the local network are wrapped to include information that identifies the reverse proxy server whereby selecting the link guarantees that the reverse proxy server will receive the corresponding request.

DIFFERENT CLIENTS AND MULTIPLE SERVERS

In the embodiments described above, the client that sends the request for the content is the same client to which the modified content is delivered. However, in alternative embodiments, the client that sends the request for the content may request the content to be sent to a different client. In such an embodiment, the client sending the

request may be part of the local network, while the client to which the modified content is delivered is outside the local network.

In addition, the embodiments described above refer to a reverse proxy server that is able to both (1) be addressed from outside the local network, and (2) address content within the local network. However, in alternative embodiments, these functions may be performed by two or more servers. For example, a first server outside the local network may receive a request and forward it to a second server within the local network. The second server may retrieve the content, modify the links to refer to the first server, and deliver the modified content to the client. Selection of the modified links would cause a message to be sent to the first server again, and the process would be repeated.

Alternatively, the second server can send the unmodified content to the first server, and the first server can modify the links with address information from the first server. Selection of the modified links would cause a message to be sent to the first server again, and the process would be repeated.

HARDWARE EXAMPLE

FIG. 4 is a block diagram that illustrates a computer system 400 upon which an embodiment of the invention may be implemented. Computer system 400 includes a bus 402 or other communication mechanism for communicating information, and a processor 404 coupled with bus 402 for processing information. Computer system 400 also includes a main memory 406, such as a random access memory (RAM) or other dynamic storage device, coupled to bus 402 for storing information and instructions to be executed by processor 404. Main memory 406 also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by

processor 404. Computer system 400 further includes a read only memory (ROM) 408 or other static storage device coupled to bus 402 for storing static information and instructions for processor 404. A storage device 410, such as a magnetic disk or optical disk, is provided and coupled to bus 402 for storing information and instructions.

Computer system 400 may be coupled via bus 402 to a display 412, such as a cathode ray tube (CRT), for displaying information to a computer user. An input device 414, including alphanumeric and other keys, is coupled to bus 402 for communicating information and command selections to processor 404. Another type of user input device is cursor control 416, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to processor 404 and for controlling cursor movement on display 412. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane.

The invention is related to the use of computer system 400 for implementing the techniques described herein. According to one embodiment of the invention, those techniques are performed by computer system 400 in response to processor 404 executing one or more sequences of one or more instructions contained in main memory 406. Such instructions may be read into main memory 406 from another computer-readable medium, such as storage device 410. Execution of the sequences of instructions contained in main memory 406 causes processor 404 to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor 404 for execution. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and

transmission media. Non-volatile media includes, for example, optical or magnetic disks, such as storage device 410. Volatile media includes dynamic memory, such as main memory 406. Transmission media includes coaxial cables, copper wire and fiber optics, including the wires that comprise bus 402. Transmission media can also take the form of acoustic or light waves, such as those generated during radio-wave and infra-red data communications.

Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punchcards, papertape, any other physical medium with patterns of holes, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, a carrier wave as described hereinafter, or any other medium from which a computer can read.

Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to processor 404 for execution. For example, the instructions may initially be carried on a magnetic disk of a remote computer. The remote computer can load the instructions into its dynamic memory and send the instructions over a telephone line using a modem. A modem local to computer system 400 can receive the data on the telephone line and use an infra-red transmitter to convert the data to an infra-red signal. An infra-red detector can receive the data carried in the infra-red signal and appropriate circuitry can place the data on bus 402. Bus 402 carries the data to main memory 406, from which processor 404 retrieves and executes the instructions. The instructions received by main memory 406 may optionally be stored on storage device 410 either before or after execution by processor 404.

Computer system 400 also includes a communication interface 418 coupled to bus 402. Communication interface 418 provides a two-way data communication coupling to a network link 420 that is connected to a local network 422. For example, communication interface 418 may be an integrated services digital network (ISDN) card

or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface 418 may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface 418 sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

Network link 420 typically provides data communication through one or more networks to other data devices. For example, network link 420 may provide a connection through local network 422 to a host computer 424 or to data equipment operated by an Internet Service Provider (ISP) 426. ISP 426 in turn provides data communication services through the world wide packet data communication network now commonly referred to as the "Internet" 428. Local network 422 and Internet 428 both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link 420 and through communication interface 418, which carry the digital data to and from computer system 400, are exemplary forms of carrier waves transporting the information.

Computer system 400 can send messages and receive data, including program code, through the network(s), network link 420 and communication interface 418. In the Internet example, a server 430 might transmit a requested code for an application program through Internet 428, ISP 426, local network 422 and communication interface 418.

The received code may be executed by processor 404 as it is received, and/or stored in storage device 410, or other non-volatile storage for later execution. In this manner, computer system 400 may obtain application code in the form of a carrier wave.

ALTERNATIVES, EXTENSIONS

In describing certain embodiments of the invention, several drawing figures have been used for explanation purposes. However, the invention is not limited to any

particular. The invention includes other contexts and applications in which the mechanisms and processes described herein is available to other mechanisms, methods, programs, and processes. Thus, the specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

For example, although client 102 was described as a highly constrained device that connected to reverse proxy server 106 via a wireless connection, in certain embodiments, client may be configured as personal computer, Lap top, workstation or other form of computer system that can connect to reverse proxy server other than through a wireless connection. For example, client 102 may instead be configured as a lap-top computer that is connected directly or indirectly (i.e., through an Internet Service Provider) to the Internet thus providing a communication path between client 102 and reverse proxy server 106 that does not include a gateway mechanism such as WAP gateway 104.

In addition, in this disclosure, certain process steps are set forth in a particular order, and alphabetic and alphanumeric labels are used to identify certain steps. Unless specifically stated in the disclosure, embodiments of the invention are not limited to any particular order of carrying out such steps. In particular, the labels are used merely for convenient identification of steps, and are not intended to imply, specify or require a particular order of carrying out such steps.